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INBREEDING AND CROSSBREEDING IN RABBIT PRODUCTION^{1/}

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What are the advantages and disadvantages of inbreeding and crossbreeding in rabbit production programs? This question has produced much lively discussion and has been argued pro and con in the rabbit industry for many years. Unfortunately, most arguments have been based on insufficient facts. For example, two breeders may have tried their individual inbreeding programs for a short period, and while one is very satisfied with his results, the other is not satisfied with his. In each case, the inbreeding involved may not have been the cause of the breeder's fancied success or failure. The cause may have been changes of an environmental nature of which the breeder was not aware, such as changes in feed quality, changes in weather, or an increase or decrease in some deleterious infectious agent.

To sum up, unless the information on inbreeding and crossbreeding in rabbits comes from well-designed trials involving adequate controls, its reliability is suspect because of environmental effects, such as the above. So far as known, there are insufficient published results of adequate trials with rabbits from which to draw definite conclusions or positively state what type of breeding program is best suited for either the producer of breeding stock or the producer of meat animals.

The U.S. Department of Agriculture receives many requests for information on the subject of rabbit inbreeding and crossbreeding. This publication is being issued to answer these requests.

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Confronted with this situation, what is to be done? Two approaches come to mind: (1) The breeder should study the results of well conducted trials in other classes of animals and plants. Since the basic genetic laws are the same for most animals and plants, one can, to a certain extent, assume that the results obtained with one class of animal will be repeated in the class of animal in which he is interested, such as rabbits. (2) The other approach, more satisfactory but also more difficult, is to carry out the necessary trials with rabbits. Both of these approaches will be examined.

INBREEDING

Although inbreeding from continued mating of close relatives can lead to increased genetic uniformity within the inbred stock and increased ability to transmit characters to the offspring in outcrosses, it also can lead to increased production of abnormal types and result in a decline in vigor. This has been supported by a foremost rabbit geneticist who, during efforts to develop inbred races of rabbits, found that inbreeding usually resulted in decline in vigor and lowered reproductive capacities.

The swine industry gives further evidence as to the effects of inbreeding on economic characters. The evidence may be summarized as follows:

- (1) Inbreeding tends to depress viability and reproductive fitness.
- (2) Conformation and type are not as subject to inbreeding depression as are viability and reproductive fitness.
- (3) Rather strong selection for larger litters and for faster growth within many mildly inbred strains has been only slightly effective, whereas selection has been effective in producing large changes in body dimensions and in carcass composition.
- (4) The decline in performance with increased inbreeding has been essentially linear and quite similar for different strains and at different experiment stations.
- (5) Crossing of inbred lines generally results in restoration of the decline in viability and performance.

There is, in general, theoretical and experimental evidence that inbreeding may produce both desirable and undesirable results; hence the rabbit breeder must carefully weigh the relevant factors in setting up this type of breeding program.

The breeder who has good stock, has a large herd, who knows livestock well, and who is familiar with the science of animal breeding and is willing to take a few chances with part of his herd, is probably in a position to attempt to develop a number of inbred lines. By a program of this sort, the breeder attempts to select the lines that will do best when crossed. By selecting among a large number of lines, the breeder may find some which excel outbred stocks when used in crosses.

Pedigree information on inbred stock can mean a great deal more than pedigree information on non-inbred stock. This is because the transmitting ability of an animal on the basis of its pedigree may be estimated with more precision for inbred stock. Thus the breeder hopes to build a reputation among progressive breeders for having stock that is uniformly good in transmitting ability. He may develop stock that is good when used within the line, that is good in crosses with other lines, or good in topcrosses (either inbred or line-cross males) on non-inbred females.

Inbred stock may deteriorate too rapidly to allow continuation of inbreeding without introduction of outside inheritance. One must keep in mind that there are a large number of lethal and semi-lethal recessive genes for various defects which have accumulated through the long period of outbreeding in rabbits. Segregation of these genes not only eliminates a substantial number of young rabbits early in life, but also makes them more susceptible to certain conditions, such as cystic kidneys and various infectious diseases.

There are many theoretical and practical hazards in a program of this sort. Unless a breeder is well appraised of them and bears them in mind each step of the way, he is well advised to avoid intense inbreeding with its attendant risks.

The breeder who has good stock and wishes to hold the inheritance of the best of it can plan a linebreeding program so as to maintain a high relationship to certain desirable individuals. Although this will require some inbreeding, it can be mild and thus does not carry much risk. This type of program is to some extent used by commercial breeders producing rabbits for market.

CROSSBREEDING

Crossbreeding has proved of value in the production of market animals in swine, sheep, cattle, and poultry. There have been extensive trials with swine and among the animals listed, this class is biologically most like the rabbit, a more detailed review of the results of crossbreeding experiments with swine is given.

Crossbreeding experiments with swine have shown, in general, an advantage for the crossbreds over the purebreds. It also has been shown that to capitalize fully on this hybrid vigor, crossbred females should be used.

The benefit from crossbreeding has been exhibited in such factors as size and weight of litter at weaning, growth rate, and feed efficiency. When used for breeding, crossbred gilts or sows, owing to their hybrid vigor, can be expected to wean slightly larger and heavier litters than purebreds.

There is not much experimental evidence as to the effect of crossbreeding on conformation and carcass quality. However, a considerable number of crossbred hogs are produced each year in the Corn Belt and about 10 percent of the pigs killed in the Danish bacon factories, which are very critical of carcass quality, are crossbreds. Therefore, it seems probable that crossbreeding if it does not affect these traits favorably at least does not affect them adversely.

The results of experiments and extension-type surveys dealing with crossbreeding of farm animals appear consistent with the genetic theory of hybrid vigor. To the extent that the breeds have performed their function of selection toward a certain goal with some increase in uniformity of the stock, hybrid vigor should be expected in crosses of these breeds. The hybrid vigor demonstrated in swine has been in no way as great and spectacular as that achieved in corn. This is because it is impractical, and probably biologically impossible, to purify and select among breeds of farm animals, to the same extent that the strains going into the corn crosses are purified through a program of intense inbreeding and selection among lines.

It is estimated that, in general, the hybrid vigor resulting from crossing breeds of farm animals is not apt to be larger than around a 10 to 15 percent increase over the average of the parental breeds for such things as size, growth rate, and fertility. For viability, as measured by the percentage of those born that reach market age, swine crossbreds show about a 10 percent advantage over the purebreds.

One familiar with livestock will realize that with the variability of farm animals being what it is, the average advantage of crossbreds over purebreds is not so great that it will show up in every cross that might be made. However, an advantage of 10 percent in a longtime operation may be very worthwhile.

Crisscrossing is a breeding plan that market hog producers have used to reap the benefits from crossbred gilts or sows. In crisscrossing, crossbred females from the first cross are mated back to a male of the same breed as one of their parents. Thereafter, males of the two breeds are alternated in producing each new generation of young from dams saved from the last generation.

Since losses to weaning and light weaning weights are serious problems in the production of fryer rabbits, the crisscross method of breeding should be adequately tested with rabbits, in view of its use by swine producers and of theoretical considerations indicating that it may give the rabbit breeder the benefit of some hybrid vigor in his stock. Figure 1 illustrates the crisscrossing type of mating.

The same type of breeding program can be extended to three breeds and is then called rotational crossing. There is some evidence in swine that the use of three or four breeds yields increasing hybrid vigor over the use of two breeds.

In any crossbreeding program, some attention should be paid to the genetic background of the breeds to be employed. Other things being equal, the more divergent the breeds are genetically, the greater is the amount of hybrid vigor to be anticipated from crossing them.

SUMMARY

Two "rules of thumb" have grown out of studies of livestock other than rabbits, in particular out of studies of swine.

1. Crossbreeding, and especially the use of crossbred females, is advantageous for production of meat animals for market.

2. The man producing and selling breeding stock might try linebreeding (a form of mild inbreeding) if he has good stock, a large herd, and will be paid for the added risks attendant upon inbreeding.

Whether these rules hold true for breeding programs in rabbit production has not been proved, but they warrant consideration in light of the results with other classes of livestock. Crisscross and rotational breeding to take advantage of hybrid vigor should be tested with rabbits.

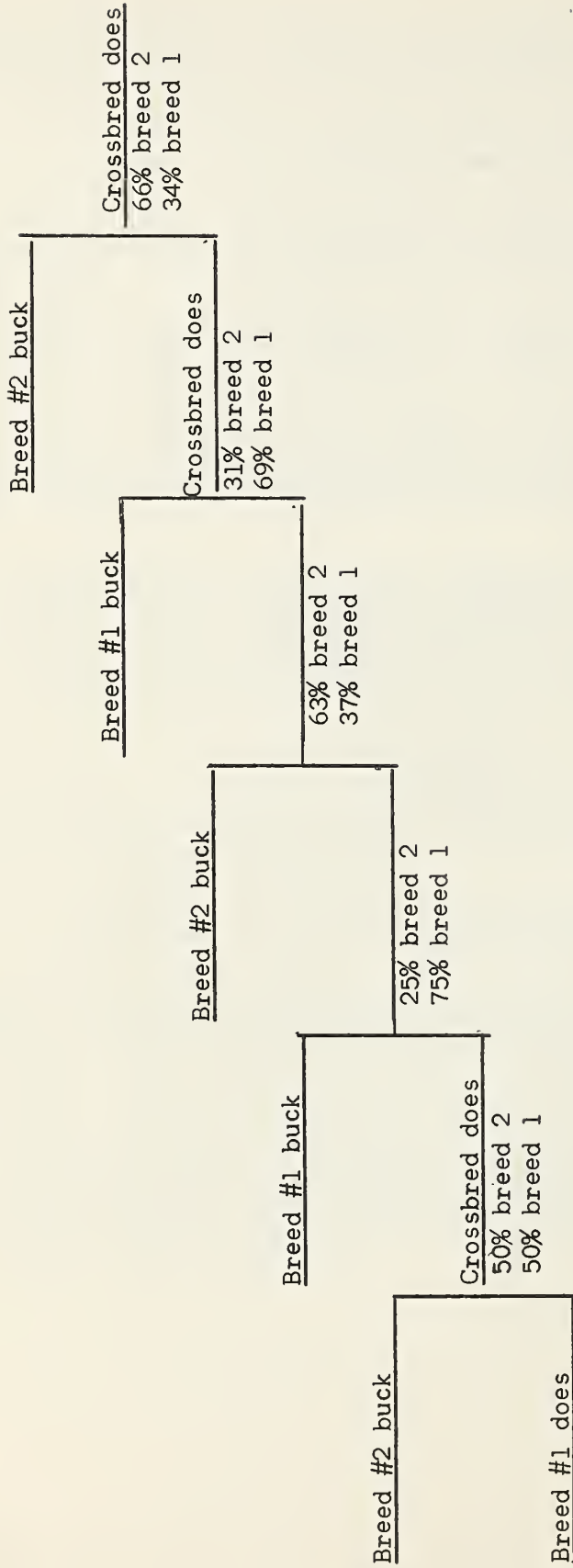


Figure 1.--Crisscrossing.

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